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NOTES ON GEOGRAPHIC DISTRIBUTION

Two rare species in Espírito Santo state, Brazil: rediscovery of *Apostolepis longicaudata* Gomes, 1921 (Squamata, Dipsadidae) and *Drymoluber brazili* (Gomes, 1918) (Squamata, Colubridae)

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Abstract. We report the rediscovery of two species of rare snake in Espírito Santo state, Brazil: *Apostolepis longicaudata* Gomes, 1921 (also rare elsewhere in Brazil) and *Drymoluber brazili* (Gomes, 1918). *Apostolepis longicaudata* has gone undetected in Espírito Santo for 66 years and *Drymoluber brazili* for 46 years. Espírito Santo state has only 10% of its forests remaining, and so the rediscovery of these forest-dwelling species emphasizes the importance of small forest remnants for the conservation. These species have been assessed as Critically Endangered and Endangered in Espírito Santo state.

Key words. Atlantic Forest, geographic distribution, rarity, threatened species

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INTRODUCTION

Rarity describes the geographical distribution and abundance of an organism (Gaston 1994) and is when a species is restricted to a few areas and in these places, there are few individuals compared to other species in the same taxonomic group. Additionally, these taxa often have unique characteristics, such as cryptic or furtive behavior, special life history strategies (Gaston and Curnutt 1998), or a clumped or patchy distribution in the habitat (McDonald and Thompson 2004) which reduces the probability of their detection (McDonald and Thompson 2004; Raphael and Molina 2007). Rarity can lead to underestimating a species' distribution and abundance if, for example, the sampling is not at the appropriate season or time of day (Raphael and Molina 2007).

Snakes are silent and elusive organisms (Greene 2001), and they are arboreal, terrestrial, aquatic, cryptozoic, or fossorial in varied types of habitats, including forest, mangroves, savanna, and cities, and are absent only in the polar zones (Castro and Silva-Soares 2016). In Brazil, 435 snake species occur (Guedes et al. 2023), of which 82 species are found in Espírito Santo state (Castro et al. 2020; Guedes et al. 2023). Some of the species of snake in this state are rather rare, such as *Apostolepis longicaudata* Gomes, 1921 and *Drymoluber brazili* (Gomes, 1918).

Apostolepis longicaudata is endemic to Brazil, with populations occurring in the Cerrado biome, but it also lives in the ecotone between the Cerrado and Caatinga biomes. Only a few records are known from the states of Tocantins, Piauí, Pará, Maranhão, Rio Grande do Norte, Paraíba, and Espírito Santo (Curcio et al. 2011; França et al. 2018; Mesquita et al. 2018; Santos et al. 2018; Nogueira et al. 2019; Marques et al. 2021; Guedes et al. 2023). Its fossorial and cryptozoic habits make it difficult to find, and therefore this species is little represented in collections. The only known population of *A. longicaudata* from the Atlantic Forest biome is in Espírito Santo (Curcio et al. 2011).

Drymoluber brazili occurs in 12 Brazilian states (Guedes et al. 2023) extending from the northeast to the southeast in the Atlantic Forest, Cerrado, and Caatinga biomes. It also lives in ecotones areas between the Atlantic Forest and the Cerrado, as well as in Paraguay (Costa et al. 2013; Nogueira et al. 2019). Its broad geographical distribution is associated with a large number of voucher specimens in museum collections (Nogueira et al. 2019), and this would lead us to classify this species as common. However, regionally, in Espírito Santo, *D. brazili* appears to be rare.

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Figure 1. *Apostolepis longicaudata*, juvenile female from Jaguaré in northern Espírito Santo, Brazil (MBML 4892). Photo: Thiago Marcial de Castro.

The first record of *A. longicaudata* from Espírito Santo is from Sooretama municipality in 1950 (MZUSP 2465). The earliest records of *D. brazili* from the state are from Baixo Guandu municipality in 1933 and 1934 (IBSP 8312 and IBSP 8836, respectively), and the third record (IBSP 37413) originates from Colatina municipality in 1974.

Here, we present the latest occurrence records in Espírito Santo for *A. longicaudata* and *D. brazili*, both rare in the state. *Apostolepis longicaudata* is also rare elsewhere in Brazil.

METHODS

Fieldwork in northern and mid-western Espírito Santo state was carried out between 2016 and 2021. We explored five forested sites for reptiles. We used pitfalls traps and visual surveys in potential microhabitats such as in leaf litter and trees, under rocks and dead tree trunks, and along streams and lagoons. Pitfall traps, consisting of a 40 L bucket buried to ground level, placed in the interior of the surveyed forest fragments. Specimen collection, when necessary, was authorized by a national and regional permit issue (IEMA no. 020/2016, IEMA no. 016/2018, and IEMA no. 031/2021). *Apostolepis longicaudata* and the first individual of *Drymoluber brazili* were found during fieldwork expeditions. The second individual of *D. brazili* was found during faunal rescue activity.

The collected individual of *A. longicaudata* was fixed in 100% ethanol and stored in 70% ethanol. The individuals of *D. brazili* were fixed in 10% formalin and stored in 70% ethanol. All these specimens are deposited in the Museu de Biologia Mello Leitão (MBML), which is part of the Instituto Nacional da Mata Atlântica (Santa Teresa municipality, Espírito Santo, Brazil).

Geographic coordinates were obtained with a Garmin Map60csX GPS receiver using the WGS84 datum.

RESULTS

***Apostolepis longicaudata* Gomes, 1921**
Figure 1

New record. BRAZIL – **Espírito Santo** • Jaguaré; 19.1129°N, 039.8696°W; 7 m alt; 17.XI.2016; in pitfall trap in preserved forest fragment; 1 ♀, adult, MBML 4892 (Figure 2).

Description. MBML 4892: 6 supralabials scales; 0 + 0 temporal scales; 7 infralabials scales; 15-15-15 dorsal scales; 1 cloacal + 1 pre-cloacal scales; 45 entire subcaudals scales; 212 ventral scales; snout–vent length 116 mm; caudal length 11 mm. The number of ventral and subcaudal scales is not precise for the reason of the poor condition of the individual.

The collected individual was identified as *A. longicaudata* because the following characters: absence of an internal scale and a black band on the tip of the tail (Ferrarezzi et al. 2005; Zaher et al. 2009);

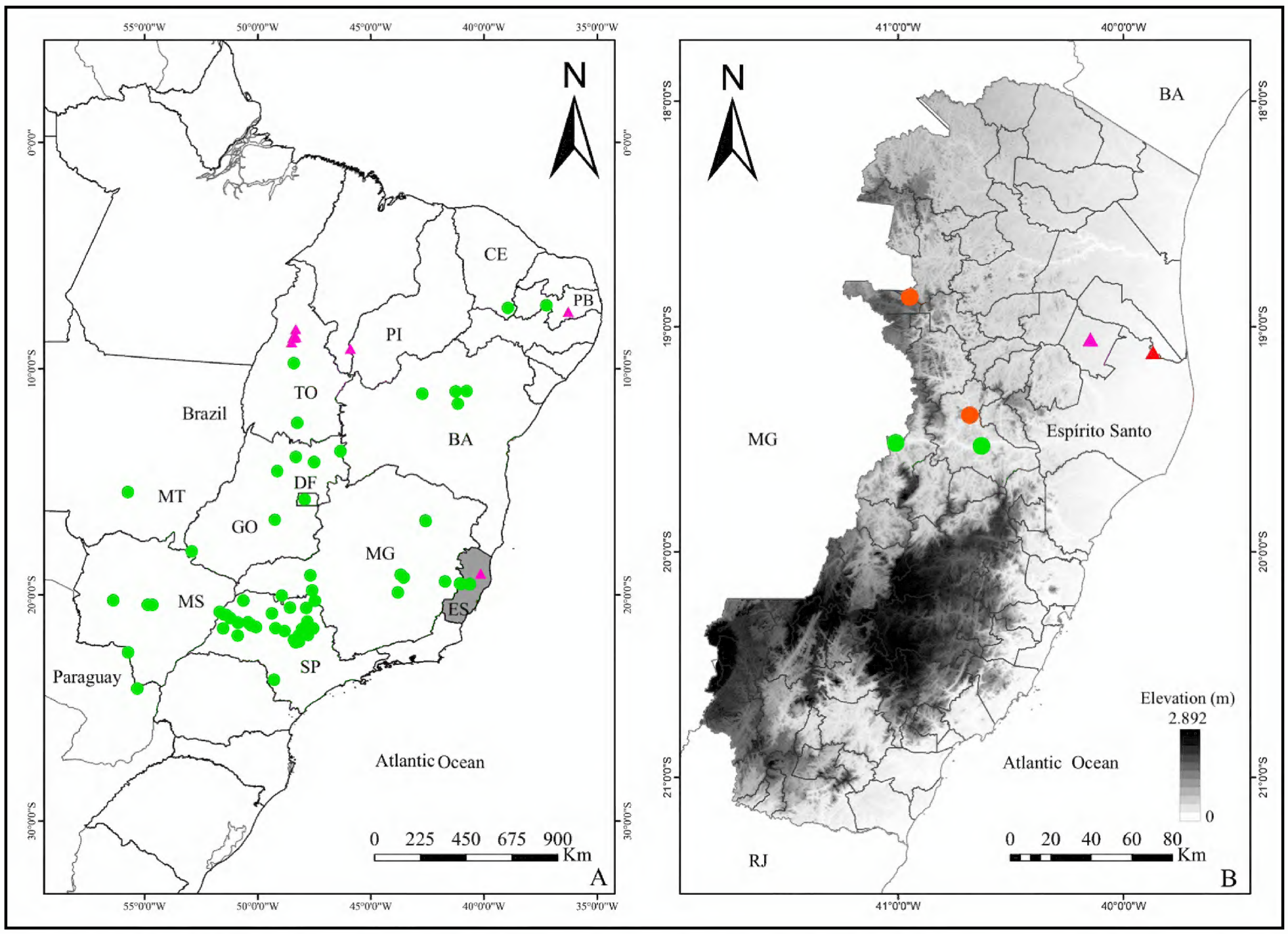

Figure 2. A. Distribution of *Drymoluber brazili* (green circles) and *Apostolepis longicaudata* (pink triangles) in Brazil. **B.** New occurrence records in the state of Espírito Santo are shown as red triangles for *Apostolepis longicaudata* and red circles for *Drymoluber brazili*.

snout–vent length up to 250 mm; 235–244 ventral scales; 49–52 subcaudal scales, 6 supralabial scales, with 2nd and 3rd scale in contact with the eyes, 7 infralabial scales, divided anal plate, and dorsal scales arranged in 15/15/15 (Curcio et al. 2011).

***Drymoluber brazili* (Gomes, 1918)**
Figures 3, 4

New records. BRAZIL – Espírito Santo • Barra de São Francisco (ES-320 highway); 18.8692°N, 040.9486°W; 379 m alt; 24.VIII.2018; crossing a highway; 1 ♀ juvenile, MBML 4375 • Colatina; 19.3936°N, 040.6819°W (WGS84); 105 m alt; 26. X. 2021; found during while removing organic soil; 1 ♂ juvenile, MBML 4895 (Figure 2).

Description. MBML 4375: 17-16-15 dorsal scales; snout–vent length 283mm; caudal length 97 mm. MBML 4895: 17-17-15 dorsal scales; snout–vent length 506 mm; caudal length 225 mm.

The collected individuals were identified as *D. brazili* because the following characters: 182–202 ventral and 109–127 subcaudal scales, 8 supralabial scales, the 4th and 5th in contact with the eyes, 9 infralabial scales, a single anal plate, split sub-tail scales, and dorsal scales arranged in 17/17/15 (Costa et al. 2013).

DISCUSSION

Apostolepis longicaudata and *Drymoluber brazili* have not found in Espírito Santo state for many years. Our record in 2016 represents the second record and the rediscovery of this species after 66 years. Therefore, in 2018 we found the fourth record for this species in ES, after 46 years. Northern area of Espírito Santo have been inventoried over the years (Bautz 2020), mainly the last remaining larger forest fragments (e.g. Reserva Natural Vale, Reserva Biológica de Sooretama, and Reserva Biológica do Córrego do Veado; Bérnils et al. 2014), while in the center-west of the state has fewer forest fragments inventoried mainly

Figure 3. *Drymoluber brazili*, juvenile female from Barra de São Francisco in northwestern Espírito Santo, Brazil (MBML 4375). Photo: Thiago Marcial de Castro.

Figure 4. *Drymoluber brazili*, adult male from Colatina in northern Espírito Santo, Brazil (MBML 4895). Photo: Raphael Rabello.

because of their size (small to medium) associated with their isolation in a matrix of grassland, pasture, and monocultures. The fragments in the mid-west have received less attention by scientific community, but brief inventories have recently been done in small and medium-sized fragments in the northern areas of the mid-west, and these two species were not found.

Apostolepis longicaudata has been recorded few times over the years in Espírito Santo, but it is also rare elsewhere in Brazil. This is likely due to its cryptozoic and fossorial habits (typical of *Apostolepis* species), which makes it difficult to observe *A. longicaudata* in the field (Harvey 1999). However, *D. brazili* is not a rare species in Brazil. One of the reasons for few records from Espírito Santo is its preference for open areas in the Caatinga and Cerrado and ecotones between Mata Atlântica and Cerrado biomes (Costa et al. 2013). There are also isolated records in Baixo Guandu and Colatina municipalities (both in Espírito Santo) at

the Espírito Santo–Minas Gerais boundary (Costa et al. 2013; Nogueira et al. 2019).

Espírito Santo was historically covered with the dense Atlantic Forests, and due to the preference of *Drymoluber brazili* to open habitats, it is unlikely that this species was ever common in the state. Alves et al. (2013) published the rediscovery of *Xenodon histricus* after 46 years; they mentioned habitat degradation as a threat to this species, which is expected for a forest-specialist species. This is exactly contrary to one of our hypotheses of the rediscovery of *Drymoluber brazili,* which has preference to open areas and has benefited from human-caused deforestation (Costa et al. 2013).

In a study of patterns of rarity in snake communities worldwide, Luiselli (2006) found that snake species with narrow ecological niches, fossorial, and dietary specialists are more susceptible to rarity, independent of continent, habitat, or climatic. *Apostolepis longicaudata* and *D. brazili* appear to present some of these characteristics.

Data on the diet of *A. longicaudata* is scarce, and there are only one observation of this species preying on a species of *Amphisbaena* Linnaeus, 1758 (Leite et al. 2022). However, records of predation for other *Apostolepis* species indicate a preference for *Amphisbaena* and small snakes: *A. multicincta* Harvey 1999 preying on *Epictia striatula* (Smith & Laufe, 1945) (Embert and Reichle 2003); *A. multicincta* preying on *Amphisbaena cegei* Montero, Sáfadez, Álvarez, 1997 (Sosa et al. 2015); *A. ammodites* Werner, 1924 preying upon *Psomophis joberti* (Sauvage, 1884) (Azevedo et al. 2018). In Brazil, there are 81 species of Amphisbaenia and only seven occurrence in Espírito Santo. Snakes belonging to the families Anomalepididae, Leptotyphlopidae, and Typhlopidae, and others in the family Dipsadidae, are also uncommon in Espírito Santo (Guedes et al. 2023). The uncommonness of its prey may be a reason for the rarity of *A. longicaudata* in Espírito Santo.

We assume that the rarity of *D. brazili* in Espírito Santo is for the same reason, although data on its diet are scarce; there is one record of this species preying on a species of Gymnophthalmidae (França et al. 2008), and Pavan and Dixo (2004) have suggested the preference of *D. brazili* for small frogs. It is probable that the diet of *D. brazili* is similar to other species of *Drymoluber* Amaral, 1930, which is mainly composed of gymnophthalmid lizards and small frogs (as we have knowledge). The family Gymnophthalmidae has 101 described species in Brazil, but only six species are known to occur in Espírito Santo (Guedes et al. 2023), and this be a caused of the rarity of *D. brazili* in this state.

Finally, rare species are at a greater risk of extinction than common species, mainly because small population size are more affected by demographic and environmental events (Boyce 1992). For this reason, understanding the causes of rarity, when it is not natural, is fundamental to promote conservation of populations of *D. brazili* and *A. longicaudata*. We recommend additional studies on the taxonomy, geographic distribution, population size, biology, and ecology of these snake species, which will serve as a baseline for conservation actions, such as the creation of conservation units. The new data presented here are from small forest fragments without any protection. Both *D. brazili* and *A. longicaudata* are threatened in Espírito Santo, where they been assessed as Endangered and Critically Endangered, respectively (Espírito Santo 2022).

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ADDITIONAL INFORMATION

Conflict of interest

The authors declare that no competing interests exist.

Ethical statement

No ethical statement is reported.

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Author contributions

Conceptualization: RSM, DHS, TMC, FGC. Data curation: TMC. Formal analysis: RSM, TMC. Investigation: RSH, DHS, TMC, FGC. Methodology: RSH, DHS, TMC, FGC. Project administration: TMC. Supervision: FGC. Writing – original draft: RSH, DHS, TMC, FGC. Writing – review and editing: RSH, DHS, TMC, FGC.

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Data availability
All data that support the findings of this study are available in the main text.

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